Prognosis for Abutment Teeth of Removable Dentures: A Retrospective Study

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Purpose: This retrospective study evaluates the clinical success of conical crown-retained removable dentures.

Materials and Methods: Ninety-seven patients were treated with 97 dentures at the University of Frankfurt, Department of Prosthodontics, between 1993 and 2000. The average observation period was 4.9 ± 2.8 years. The dentures were supported by 445 natural abutment teeth. To evaluate the long-term success of the restorations, the variables ***abutment loss***, ***tooth mobility***, ***mean probing depths***, and ***radiological bone loss*** were used. Data were obtained by one clinical examiner at baseline, by systematic evaluation of patient records, and at clinical re-examinations. Survival-time methods were used to analyze time-to-event data. Specifically, the Cox model with frailty term was applied to account for correlations between intra-patient survival data. Thirty abutment teeth had to be extracted during the observation period.

Results: Statistical analysis showed no significant effects of the variables ***tooth mobility*** ($p = 0.42$), ***mean probing depths*** ($p = 0.23$), and ***radiological bone loss*** ($p = 0.59$) on the time to tooth extraction. For the non-extracted abutment teeth significant changes during time for the variables ***tooth mobility*** ($p < 0.0001$) and ***radiological bone loss*** ($p = 0.0240$) were observed.

Conclusion: Removable partial dentures retained by conical crowns have a favorable clinical prognosis

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INDEX WORDS: removable dentures, conical crown, abutment teeth, tooth mobility, mean probing depth, radiological bone loss

COMBINED FIXED-removable restorations with conical crowns as perioprosthodontic retainer elements are a therapeutic method to restore the structures of the masticatory system in the partially edentulous jaw. Several scientific publications exist reporting the long-term clinical results of such restorations; however, these reports are very different with regard to patient populations, observation periods, and parameters examined.[1-7]

Removable partial dentures (RPDs) lose their function for many reasons. One important parameter for evaluating the long-term clinical result of conical crown-retained RPDs is abutment assessment. The abutment loss event is thus a criterion for assessing the treatment result.

The scientific literature contains several reports related to the prognosis of abutment teeth and to related variables potentially suitable as predictors. Heners and Walther[8] cite periodontal involvement, caries, and dental fractures as the main causes of tooth loss in the context of RPDs. Periodontally compromised abutment teeth[9] and RPDs supported by only a few residual natural teeth[8] had lower survival rates than periodontally healthy abutment teeth or RPDs with four or more abutment teeth. The positive effect of a regular re-examination scheme on the long-term success of fixed-removable restorations is undisputed.[10,11]

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Figure 1. Definitively cemented high-gold primary copings on abutments 4, 5, 6, 8, 10, and 11 (to support the partial denture).

Figure 3. In the mandible, the primary copings have been definitively cemented on abutments 21, 22, 27, 28, and 29.

The objective of the present retrospective study was to assess the prognosis of abutment teeth, to identify variables (tooth mobility, mean probing depths, and radiological bone loss) that influence the prognosis of abutment teeth of conical crown-retained RPDs, and to examine time-dependent changes in the values for these variables.

Materials and Methods

Patient Population

Between 1993 and 2000, 173 patients at the Dental School at the University of Frankfurt received conical crown-retained RPDs. The dentures were produced at the Department of Prosthodontics by specially instructed treatment providers following a uniform treatment concept. In 2001, all 173 patients were contacted either by postal mail or by telephone. Ninety-seven patients (40 men, 57 women, average age: 59.8 ± 8.4 years) having 97 conical crown-retained RPDs were available for re-evaluation. Ninety-one partial dentures featured a transversal framework design (with transversal bar) (Figs 1 and 2), and six featured a dentoalveolar framework design (with no major connector) (Figs 3 and 4). The reasons for non-attendance of the remaining 76 patients were: death, disease, or moving out of area in 46 (61%) cases, and a lack of interest and unknown reasons for 30 (39%) patients. The average observation period of the re-examined 97 conical crown-retained dentures was 4.9 ± 2.8 years.

The dentures were supported by 445 natural abutment teeth (maxillary: 231; mandibular: 214). Of the 445 abutment teeth, 369 were vital and 76 were nonvital. The distribution of the number of abutment teeth per denture is shown in Table 1.

Figure 2. Conical crown-retained denture in place, occlusal view. This maxillary denture shows a transversal framework design with a transversal bar.

Figure 4. The completed denture features a dentoalveolar framework design with no major connector (sublingual bar).

How the inserted restorations were supported by the residual dentition was classified according to categories defined by Steffel.[12] A total of 48 restorations had quadrangular support, 41 restorations had triangular support, and eight dentures had linear transversal support. RPDs with one supporting point were not found in the patient population. Also, the 97 conical crown-retained RPDs were evaluated according to the Kennedy classification. There were 56 dentures with Class I arches, 31 with Class II arches, and 10 with Class III arches. Kennedy Class IV was not represented.

Data

The variables *abutment loss*, *tooth mobility*, *mean probing depths*, and *radiological bone loss* were analyzed. In the present study, one clinical examiner compared initial clinical and radiological parameters (before denture fabrication) with the findings at the clinical re-examination to assess the prognosis of conical crown-retained RPDs. Data of abutment loss were obtained based on systematic evaluation of patient records.

Abutment loss

All cases of abutment loss during function were registered for time, location, and extraction indication. Abutment life was measured as the time difference between cementation and extraction or the end of the observation period, whichever occurred first (censored data).

Tooth mobility for abutment teeth

The degree of mobility was evaluated as follows: physiological mobility = M0; mobility is felt but not seen (judged by tactile sensitivity) = M1; horizontal mobility, can be seen (judged by observation) = M2; pronounced visible horizontal and vertical mobility (apparent mobility) = M3.[13]

Probing depths on abutment teeth

Mean probing depths were measured using a rigid periodontal probe with a millimeter calibration (PWHO; Hu-Friedy, Chicago, IL) on the mesial and distal tooth surfaces.

Table 1. Denture Support Type

Number of Abutment Teeth per Denture	*n (%)*
2	3 (3.1)
3	17 (17.5)
4	33 (34.0)
5	25 (25.8)
6	8 (8.2)
7	5 (5.2)
8	5 (5.2)
9	1 (1.0)

Radiological bone loss

Radiological bone loss around the abutment teeth was determined by analogy with Håkansson's method.[14] To get an estimate of the extent of bone loss, abutment teeth were examined using single-tooth radiographs in rectangular technique. The tooth root was divided into four logical quarters, from coronal to apical, and it was determined whether the bone crest was at the level of the coronal (first), second, third, or apical (fourth) root quarter. Bone loss was determined both for the mesial and for the distal side of the root. For this examination, the initial radiograph (taken prior to inserting the restoration) was compared to the radiograph taken at the time of the clinical re-examination. Teeth were assigned to the group corresponding to the greatest extent of measured bone destruction.

Statistical Data Analysis

For the continuous data, means and standard deviations were calculated. A two-stage procedure was applied to take correlations within patient data into account. First, means were calculated for the tooth data within patients; then, statistical analyses were performed for these patient means. The paired t-test was used for before-after comparisons.

For time-to-event data, survival-time methods were used based upon the non-aggregated teeth data. The Cox model with frailty term was applied to account for correlations of the teeth survival data within patients.

Results

Clinical Success of Abutment Teeth

Of the 445 natural abutment teeth of 97 conical crown-retained RPDs, 30 (6.7%) abutment teeth were extracted. The mean observation period was 4.9 (SD 2.8) years. At an average observation period of 4.9 ± 2.8 years, this corresponds to an extraction rate of 6.7%. Of the extracted abutment teeth, 18 were maxillary and 12 mandibular. At extraction, 18 of the 30 extracted abutment teeth were vital, while 12 were non-vital. Three abutment teeth had to be treated endodontically after denture insertion. The causes for abutment loss were: periodontal problems (18 abutment teeth), fractures (10), and dental caries (2). Total loss of function occurred in five of the 97 dentures.

Prognosis of Abutment Teeth

Gross descriptive statistics showed increased extraction risks for abutment teeth with increased tooth mobility, mean probing depths, or

Table 2. Distribution of Tooth Mobility, Mean Probing Depths, and Radiological Bone Loss at Baseline

Tooth Mobility		*Mean Probing Depth*		*Radiological Bone Loss*	
	n (%)		*n (%)*		*n (%)*
M0	182 (44.7)	0 to 2 mm	61 (14.8)	1st quarter	283 (66.3)
M1	161 (39.6)	3 to 4 mm	296 (71.8)	2nd quarter	140 (32.8)
M2	60 (14.7)	5 to 6 mm	47 (11.4)	3rd quarter	4 (0.9)
M3	4 (1.0)	>6 mm	8 (1.9)	4th quarter	0 (0)

radiological bone loss; however, after taking the correlations of the teeth data within patients into account by using the Cox model with frailty term, no significant effects on the time to tooth extraction of the three variables *tooth mobility* ($p = 0.42$), *mean probing depths* ($p = 0.23$), and *radiological bone loss* ($p = 0.59$) could be found.

Time-dependent Changes

Descriptive data of the variables *tooth mobility, probing depths*, and *radiological bone loss* of abutment teeth are shown in Table 2. The mean observation period for the non-extracted abutment teeth was 5.1 ± 2.8 years. For the non-extracted abutment teeth, significant time effects for the two variables *tooth mobility* ($p < 0.0001$) and *radiological bone loss* ($p = 0.0240$) were found during the observation period. For the mean probing depths, no significant change was observed over time. On average, tooth mobility increased by 0.15 units per year and radiological bone loss increased by 0.02 units per year. Mean probing depths decreased slightly, but this result was not statistically significant (Table 3).

Discussion

When interpreting the results presented here, keep in mind that direct comparison with other published data is possible only to a limited extent, as the respective studies[1-7,15,16] differ from the present study with regard to the patient populations observed and with regard to mean observation times.

Hultén et al[7] were able to follow 73% of their patients after a mean observation time of 3.3 years. Kern and Wagner[1] achieved a follow-up level of 50% after a mean observation time of 10.0 ± 0.3 years. The studies cited included no systematic recall program. Bergman et al[6] were able to examine 21 of 28 patients after observation periods of 4 to 5.5 years, a follow-up rate of 75%. The publications by Wenz et al[2] and by Igarashi and Goto[5] do not make any mention of dropout percentages. The relatively low number of patients followed in the present study (56% after a mean observation period of 4.9 ± 2.8 years) could be attributed to the absence of a formal recall program.

Reports of abutment loss rates in the literature vary. The present retrospective study evaluated 97 conical crown-retained RPDs with 445 abutment teeth, 30 of which had to be extracted. At an average observation period of 4.9 ± 2.8 years, this corresponds to an extraction rate of 6.7%. Following an average of 30.1 months *in situ*, Molin et al[17] found an abutment loss rate of 3.2% in 60 retrospectively followed conical crown-retained

Table 3. Mean Annual Changes over the Observation Period Regarding Tooth Mobility, Mean Probing Depths, and Radiological Bone Loss for Non-extracted Abutment Teeth

Differences of the Variables (units per year)*						
Variable	*N*	*Mean*	*Standard deviation*	*P-value*	*Lower 95% CL for mean*	*Upper 95% CL for mean*
Tooth Mobility	88	0.15	0.34	<0.0001	0.08	0.22
Mean Probing Depth	89	–0.04	0.30	0.1749	–0.11	0.02
Radiological Bone Loss	91	0.02	0.09	0.0240	0.003	0.04

*For the purposes of data analysis, the rankings were assigned to values on a scale: tooth mobility (values of 0 to 3 corresponding to M0 to M3), mean probing depth (values of 1 for 0 to 2 mm to 4 for >6 mm), and radiological bone loss (values of 1 to 4 for the 1st to 4th quarters).

RPDs. Bergman et al[6] found a higher loss rate (9%) during an observation period of up to 67 months. Hultén et al[7] found a loss rate of 7.7%. Saito et al[18] found a loss rate of 11.4% of 27 telescope-retained restorations after an observation period of 8.5 years on average.

Within the framework of the present study, the cause of abutment loss was periodontal in 60% of the cases. The second most frequent cause was fractures (33%). Similar results were obtained by Walther and Heners[9] in their study of initial periodontal findings and the abutment prognoses of conical crown-retained RPDs.

Nickenig and Kerschbaum,[19] comparing abutment loss rates for maxillary and mandibular telescope crowns, showed that the loss rate was higher for the maxilla, at 14.3%, than for the mandible, at 5.5%. The present study, too, found a higher extraction rate in the maxilla. By contrast, Heners and Walther[20] found no significant differences in abutment loss between maxillary (4.1%) and mandibular (3.7%) conical crowns.

Heners and Walther[8] examined the prognosis of 2094 abutment teeth in conical crown-retained RPDs in patients with only few natural teeth remaining. For restorations with three abutment teeth or fewer, the risk of loss was significantly higher, especially with a dentoalveolar framework design. By contrast, the above authors state that there were no significant differences in survival rates between the dentoalveolar and the transversal framework designs in those cases where the restoration was supported by more than three abutment teeth. The present study was not suited to demonstrate any differences between framework designs, as nearly all restorations had transversal framework designs.

When examining the present results for a correlation between abutment loss and Kennedy classifications, a crude log rank analysis shows that the Kennedy classification appears to have an impact on the time to abutment tooth loss. In the Cox model with frailty term, taking correlations of teeth survival data within individuals into account, this statistical significance disappears; however, it should be noted that the sample size was too low to have sufficient power to detect a true effect of the Kennedy classification. Only 30 abutment teeth had been extracted. Stratifying the data into 10 strata according to Kennedy classes resulted in strata with very low event numbers. A possible influence of the Kennedy classification on the outcome could therefore neither be ruled out nor confirmed.

Tooth mobility for abutment teeth increased by 0.15 units per year during the observation period. This increased mobility might be attributable to the physiological aging process and concomitant changes in the periodontal structures. Svanberg et al[21] pointed out that tooth mobility may increase as a result of adaptive, non-pathological changes in the absence of any inflammatory symptoms. A clinically demonstrable increase in tooth mobility was shown by the results of Ericson et al[22] and Igarashi and Goto.[5] Stark and Schrenker,[11] examining telescope-retained dentures, found a primary decrease in mobility within the first 3 years after insertion; after that, mobility increased again. Other studies, by contrast, did not show any indication of increased tooth mobility over the functional life of RPDs;[10,23] however, all the above studies determined tooth mobility manually and not with a Periotest device. In the study by Kern and Wagner,[1] increased abutment mobility could be demonstrated 10 years after the insertion of conical crown-retained RPDs using a Periotest device.

The present results showed no clinically relevant changes in mean probing depths on abutment teeth; however, there is disagreement in the literature as to changes in probing depth around abutment teeth of conical crown-retained RPDs. Nickenig et al[24] found no or almost no time-dependent changes in periodontal parameters such as mean probing depths and sulcus bleeding indexes near conical crown-retained RPDs. The studies of Kern and Wagner[1] on the other hand, did show an increase in probing depths.

There were statistically significant changes in radiological bone loss during the observation period. At a change rate of 0.02 units per year, however, this would have to be rated a very slight increase in alveolar bone loss. Radiological bone loss remained largely stable between baseline and re-examination. These results agree well with those of other extant studies.[23,25]

When interpreting the present results, it should be noted that the statistical analysis of data might influence the evaluation of the results. This can be illustrated as follows: When examining the influence of the variables (*tooth mobility, mean probing depths, and radiological bone loss*) on the extraction risk, one fact is salient on a purely descriptive level: of four cases with Class III bone loss, two resulted in extraction (risk: 50%). However, since this result is ultimately based on only four observations, it is not statistically stable. When using a method that takes into account the data correlation, the significant effect on bone loss disappears (p = 0.39). On the other hand, the frailty term, that is, the interpatient dependency, is highly significant (p = 0.0042). This result remains stable in that only the frailty term is significant even in frailty models including all three factors, whereas all three potential predictors are not significant—independent of whether ordinal predictors (model #2) or binary predictors (model #3) are used. When including other factors such as sex, age, and jaw configuration, no significant effects were seen in the present results. This model with its six predictors is overloaded, given the small size of the sample (n = 30 extractions), so that model #2 with frailty term was used as the most suitable model for analysis.

Conclusion

It can be asserted that RPDs retained by conical crowns have a favorable clinical prognosis; however, a multi-centric study (to obtain a larger sample) is desirable to gain additional insight into the influence of demonstrable predictor variables on the prognosis of abutment teeth.

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